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kooed emis u-ah,' meaning by this that they had 'seen many.' They gave the duck the name 'Argly' and told me in the spring I could get many, also their eggs, at the head of our own bay. I was disappointed when the spring came to have my Labrador Duck materialize in the form of the Long-tailed Duck, which sure enough was very plentiful at the head of the bay.

"In August, 1892 (the latter part, I believe), on our way home we touched at Godthaab, the largest town in Greenland. Here we were entertained by Herr Anderson, the Danish Inspector of South Greenland, an accomplished naturalist, and at his house I had the pleasure of inspecting one of the finest collections of Arctic birds I have ever seen. I showed him my little pamphlet on the Labrador Duck, and also presented it to him on my departure. He told me that his collection represented twenty years' work, and all the hunters in South Greenland (some 500 men) had instructions to bring to him any strange birds that they might get. In this way he has added to his collection from time to time many rare birds and eggs. In all this time he claims to have heard nothing of the Labrador Duck, which I consider is substantial proof that within the last twenty years the Labrador Duck has not visited Greenland. From Godthaab we came directly home to Philadelphia, and this ended my ineffectual attempts at learning something more definite regarding this species."

REMARKS ON THE ORIGIN OF BIRD MIGRATION.¹

BY FRANK M. CHAPMAN.

AS A TEXT for the remarks I have to offer on this subject I have taken the following paragraph from Dr. Allen's paper on the 'Origin of the Instinct of Migration in Birds': "Nothing

¹ Read at the Eleventh Congress of the American Ornithologists' Union, held in Cambridge, Mass., Nov. 20-23, 1893.

² Bull. N. O. C., V, 1880, [pp. 151-154.

is doubtless more thoroughly established than that a warm temperate or sub-tropical climate prevailed down to the close of the Tertiary epoch, nearly to the Northern Pole, and that climate was previously everywhere so far equable that the necessity of migration can hardly be supposed to have existed. With the later refrigeration of the Northern regions, bird life must have been crowded thence towards the tropics and the struggle for life thereby greatly intensified. The less yielding forms may have become extinct; those less sensitive to climatic change would seek to extend the boundaries of their range by a slight removal northward during the milder intervals of summer, only, however, to be forced back again by the recurrence of winter. Such migration must have been at first 'incipient and gradual,' extending and strengthening as the cold wave receded and opened up a wider area within which existence in summer became possible. What was at first a forced migration would become habitual and through the heredity of habit give rise to that wonderful faculty we term the instinct of migration."

This theory gives us, I think, as satisfactory a working hypothesis of the origin of bird migration in North America as we can hope to have. The few words I have to say relate to the influences which may have aided climatic conditions in establishing the habit of migration and which are probably effective in governing it to-day.

Most animals have an instinctive desire for seclusion during the season of reproduction, and when this season approaches will seek some retired part of their range or haunts in which to rear their young. Even our domesticated hens, turkeys, ducks, and pea-fowl, if given freedom, often travel a greater or less distance in search of a place where they may conceal their nests. Many species of tropical sea-birds resort each year to some rocky islet, situated perhaps in the heart of their habitat, where they may nest in safety. This is not migration in the true sense of the word, but nevertheless the object is the same as that which prompts a Plover to migrate to the Arctic regions, and, be it further noted, the movement is just as regular. These sea-birds pass their lives in the tropics, their presence or absence in any part of their range being largely dependent upon the food-supply. But, as in the case of a Warbler which nests in Labrador, they

are all affected at nearly the same time by an impulse which urges them to hasten to a certain place.

This impulse is periodic and is common to all birds. There is a regular nesting season in the tropics, just as there is a regular nesting season in the Arctic regions. It is evident, therefore, that external conditions have not created this impulse, though it is possible that in many instances they may have governed its periodicity. On the contrary, its causes are internal. In the case of the sea-birds, for example, dissection will show an enlargement of the sexual organs and it is this physiological change which warns the birds that the season of reproduction is at hand.

The organs of male birds apparently begin to enlarge before those of the females, and it is not improbable that this may account for the earlier migration of the males of many species. Furthermore, individuals found south of the breeding range of the species during the nesting season are generally barren birds, and their presence may be due to an absence of conditions which would impel them to migrate to the nesting grounds.

Now returning for a moment to the period of glaciation, it is not improbable that the period of reproduction may have been coincident with the return of the warmer part of the year and, in addition to the desire for seclusion and the pressure exerted by the crowded conditions of existence which then prevailed, was potent in inducing birds to seek breeding grounds in the north during the summer.

I do not presume to attempt to trace the varied influences of changing climate which, acting with the factors I have mentioned, have brought about the conditions of the avifauna of to-day, with its resident species and transient visitants, but will speak briefly of the two classes of our strictly migratory birds.

These are, first, those which breed continuously from our southern borders to the northern limit of their range; second, those in which an area of varying extent exists between the southern limit of their breeding range and our southern boundaries.

Examples of the first class are *Tyrannus dominicensis*, *Vireo calidris*, *Dendroica virgorsii*, and *Compsothlypis americana*. I believe the presence of these birds to be due to normal

extension of range. Certainly in the case of the first two there can be no doubt that in this way we can account for their occurrence in the United States. In them we have two abundant West Indian species, which, with a number of others, have become established on our southern boundaries. Whether they will gradually increase their northern range, as others have done before them, will of course depend upon the conditions they encounter. The second two present a similar case carried to greater extreme. The Pine-creeping Warbler nests from Cuba to New Brunswick, the Parula Warbler nests from Florida and Texas northward to Canada, and in its various closely related forms is found as far south as Brazil. These, like the two preceding, we may consider normal instances of extension of range.

In our own experience we have seen how readily a species responds to favorable conditions and how quickly it takes possession of territory adjoining its habitat when the conditions are favorable. These conditions I think are, first, absence of competition with species of similar habits; second, an abundance of food. Temperature I consider of importance only as it affects the food-supply.

The Pine Warbler (*Dendroica vigorsii*) illustrates this. Its habits demand pine forests and it is equally at home during the summer from the pines of western Cuba to those of New Brunswick and Manitoba. Its breeding range, therefore, lies between the summer isotherms of 80° and 64°, — excellent evidence that temperature alone is not the factor which determines its distribution, but temperature as it governs environment.

The Warblers which nest in the Canadian Fauna are good examples of our second class of migrants, or those whose breeding range is entirely north of our southern limits. Here we have species many of which winter in Central or South America and, returning in the spring, pass over thousands of miles to reach the region of their birth. I take it for granted that the members of this second class of more northerly migrants became North American at an earlier period than the members of the first class. This I think is proven by a study of the first class, in which we find species even now entering our limits, and also because it would be unheard of for a species to move its entire habitat thousands of miles, as these Canadian birds would have

had to do if we suppose them to have become North American since the advent of the members of the second class. Doubtless they may once have represented the first class and perhaps at that time all our migrants were confined to our southern borders,—this being presumably the condition of things during the period of glaciation,—but as a gradually changing climate advanced the isotherm which bounded the northern limit of their range, and with it the conditions they required, they followed it northward until even the southern limit of their summer home was carried further north than the northern limit had previously been, except where altitude gave them the surroundings needful to their existence.

As an illustration of how a northern habitat might be acquired I will instance the case of our Common Tern (*Sterna hirundo*) on the Atlantic coast. It is only a few years since this species was an abundant breeder along the greater part of the coast, but a demand arose for these birds for millinery purposes and, as the result, they are now restricted during the breeding season to comparatively few localities. On Long Island, for example, this Tern was a common summer resident but those birds which nested on the mainland were easily accessible to hunters and were soon exterminated, until at present few or no Terns nest on Long Island except a colony of about 1000 pairs confined to the small, uninhabited, isolated islet known as Big Gull Island. On the Massachusetts coast, practically the same thing has happened and Terns are now largely restricted to Muskeget Island.

What has occurred on Long Island and in Massachusetts will doubtless take place throughout the larger part of this Tern's American range. It breeds now from the Gulf of Mexico to the Arctic regions, but is the day far distant when the Common Tern will be unknown as a breeding bird in that part of its present summer habitat inhabited by man? Then its breeding range in America will be a boreal one, and just as the Terns of Big Gull and Muskeget Islands return year after year to the home of their birth, so will these northern breeding Terns return to their Arctic home, and have thus established a habitat similar to those of the birds in the second class of migrants I have mentioned.

But we may learn another lesson from these island-nesting birds.

Their case seems to me to be closely parallel to that of the sea-birds previously cited. It is probable that in both cases these colonies owe their origin to the instinct which guides a bird to return to the place of its birth. Those individuals which selected the most favorable breeding ground would rear their young in safety and the young returning would aid in forming a future colony. On the other hand, the progeny of those birds which did not select so safe a home would be less likely to survive.

Of this wonderful 'homing instinct' which plays so important a part in the migration of birds I have no explanation to offer. We know, however, that it exists, not only in birds, but in many other animals. It is this instinct, aided by the 'heredity of habit,' which guides a bird to its nesting ground. The Carrier Pigeon is taught its lines of flight by gradually extending its journeys; a species learns its routes of migration by gradually extending its range.

As for the desertion of the breeding grounds and consequent fall migration, there seems to be no question that it is due mainly to the failure of the food-supply. Nevertheless, many species of birds migrate long before there is apparently any reason for their doing so. Early in July the Snipes and Plovers begin to appear from their nesting grounds in the north. The first of August finds numbers of our land-birds crossing the Gulf of Mexico en route to their southern homes. Now, it has been frequently asked, if failure of the food-supply is the cause of the fall migration, why do these birds leave their breeding grounds at so early a date? In reply I would ask, why should they remain? The object for which they came is accomplished, and unless they are offered some special inducement to stay, why should they not return to the regions in which — and I would emphasize this — many of them pass two-thirds of the year?

The sea-birds I have mentioned desert their barren homes as soon as their young are on the wing. The Arctic-nesting Snipe and Plover hasten from the north to more fruitful feeding grounds further south. In fact, as soon as the cares of the nesting season are over, the summer home seems to possess few attractions. Some birds at once hurry back to their southern resorts, while others wander at will around the country, pausing wherever food is abundant, and do not retreat southward until they are actually forced to do so.